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CONFIDENTIAL

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STATE OF FLORIDA
DIVISION OF ADMINISTRATIVE HEARINGS

IN RE: FUEL AND PURCHASED POWER COST RECOVERY CLAUSE WITH GENERATING PERFORMANCE INCENTIVE FACTOR,

Case No. 19-6022

_____/

RECOMMENDED ORDER

Pursuant to notice, a final hearing was conducted in this case on February 4 and 5, 2020, in Tallahassee, Florida, before Lawrence P. Stevenson, a duly-designated Administrative Law Judge ("ALJ") of the Division of Administrative Hearings ("DOAH").

APPEARANCES

For Duke Energy Florida, LLC ("DEF" [1]):

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[1] References to DEF include Progress Energy, DEF's predecessor in interest in the Bartow power plant that is the subject of this proceeding. DEF purchased Progress Energy in 2011.

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STATEMENT OF THE ISSUES

Two issues have been referred by the Commission to DOAH for a disputed-fact hearing:

ISSUE 1B: Was DEF prudent in its actions and decisions leading up to and in restoring the unit to service after the February 2017 forced outage at

the Bartow plant and, if not, what action should the Commission take with respect to replacement power costs?

ISSUE 1C: Has DEF made prudent adjustments, if any are needed, to account for replacement power costs associated with any impacts related to the de-rating of the Bartow plant? If adjustments are needed and have not been made, what adjustment(s) should be made?

PRELIMINARY STATEMENT

On January 2, 2019, the Commission opened Docket No. 20190001-EI, *In re: Fuel and purchased power cost recovery clause with generating performance incentive factor,* commonly referred to as the "Fuel Clause" docket. The Fuel Clause docket is a recurring, annual docket to which all investor-owned electric utilities serving customers in Florida are parties. Through the Fuel Clause docket, utilities are permitted to recover reasonably and prudently incurred costs of the fuel and fuel-related activities needed to generate electricity. Among the issues raised in the 2019 Fuel Clause docket was DEF's request to recover the replacement power costs incurred in connection with an unplanned outage to the steam turbine at DEF's Bartow Unit 4 combined cycle power plant (the "Bartow Plant") in February 2017. Issues 1B and 1C were raised as part of the 2019 Fuel Clause docket.

On November 5, 2019, the Commission held a final hearing in the 2019 Fuel Clause docket. All issues related to DEF's request to recover its fuel and purchased power costs were addressed, except for Issues 1B and 1C. Both Issues 1B and 1C involved extensive claims of confidentiality with respect to the pre-filed testimony of DEF witness Jeffrey Swartz, OPC witness Richard Polich, and the proposed trial exhibits.

The Commission found that it was impracticable to conduct direct or cross-examination in an open hearing without extensive reference to

confidential material. Despite its apparent authority under section 366.093, Florida Statutes, to declare documents confidential, the Commission took the position that it lacked authority to close a public hearing to protect materials and topics it had previously determined to be confidential. The Commission therefore referred Issues 1B and 1C to DOAH for a closed evidentiary hearing and issuance of a Recommended Order.

On November 26, 2019, a telephonic status conference was held to set hearing dates, establish the procedures for handling confidential material, the need for discovery, the use of written testimony, and the use of the Comprehensive Exhibit List ("CEL") admitted into evidence at the Commission's November 5, 2019, hearing. At the status conference, the parties agreed to the hearing dates of February 4 and 5, 2020. The undersigned requested the parties to confer and file a motion setting forth proposed procedures for the handling of confidential material before, during, and after the hearing. The parties filed a Joint Motion on Confidentiality on December 6, 2019, which was adopted by Order issued December 9, 2019.

On December 23, 2019, the Commission's record was transmitted to DOAH on two CD-ROM discs. Disc One contained non-confidential information and Disc Two contained information held as confidential.

The final hearing was convened and completed as scheduled on February 4 and 5, 2020. At the outset of the hearing, the parties submitted an updated CEL from the November 2019 proceeding before the Commission. The revised CEL listed 114 exhibits. The revised CEL was numbered as Exhibit 114 and admitted by stipulation.

DEF presented the direct and rebuttal testimony of Jeffrey R. Swartz, its Vice President of Generation. DEF moved for the admission of Exhibits 80 through 82, which were admitted into the record.

OPC presented the testimony of Richard Polich, an engineer with expertise in the design of power generation systems, including steam turbines. OPC moved for the admission of Exhibits 68 through 75 and 101 through 109, which were admitted into the record. At the hearing, OPC Exhibits 115 through 117 were marked, moved, and admitted into the record.

The Commission moved for the admission of Exhibits 110 and 111, which were admitted into the record.

FIPUG moved for the admission of Exhibit 118, which was admitted into the record.

White Springs moved for the admission of Exhibits 112 and 113, which were admitted into the record.

The three-volume Transcript of the final hearing was filed with DOAH on February 24, 2020. Pursuant to an agreement approved by the undersigned, the parties timely filed their Proposed Recommended Orders on March 20, 2020. DEF and the Commission filed separate Proposed Recommended Orders. OPC, FIPUG, and White Springs submitted a joint Proposed Recommended Order (unless otherwise specified, references to OPC as to positions stated in its Proposed Recommended Order should be understood to include FIPUG and White Springs). All three Proposed Recommended Orders have been duly considered in the writing of this Recommended Order.

Unless otherwise indicated, statutory references are to the 2019 edition of the Florida Statutes.

FINDINGS OF FACT

Based on the evidence adduced at hearing, and the record as a whole, the following Findings of Fact are made:

THE PARTIES

1. The Commission is the state agency authorized to implement and enforce Chapter 366, Florida Statutes, which governs the regulation of every "public utility" as defined in section 366.02(1).

2. DEF is a public utility and is therefore subject to the Commission's jurisdiction. DEF is a subsidiary of Duke Energy, one of the largest energy holding companies in the United States.

3. OPC is statutorily authorized to represent the citizens of the state of Florida in matters before the Commission, and to appear before other state agencies in connection with matters under the Commission's jurisdiction. § 350.0611(1), (3), and (5), Fla. Stat.

4. FIPUG is an association comprising large commercial and industrial power users within Florida. A substantial number of FIPUG's members are customers of DEF.

5. White Springs operates energy intensive phosphate mining and processing facilities in Hamilton County and is one of DEF's largest industrial customers.

THE BARTOW PLANT

6. The Bartow Plant is a 4x1 combined cycle power plant composed of combustion turbine generators whose waste heat is used to produce steam that powers a steam turbine manufactured by Mitsubishi Hitachi Power Systems ("Mitsubishi"). "4x1" references the fact that there are four Siemens

180 megawatt ("MW") Type 501 F combustion turbines, each connected to one of four heat recovery steam generators ("HRSG"), all of which in turn are connected to one steam turbine.

7. A combined cycle power plant uses gas and steam turbines together to produce electricity. Combustion of natural gas in the combustion turbine turns a generator that produces electricity. The waste heat from the combustion turbine is routed to an HRSG. The HRSG produces steam that is then routed to the steam turbine which, in turn, generates extra power.

8. Combined cycle plants can be set up in multiple configurations, providing considerable operational flexibility and efficiency. It is not necessary for all four HRSGs to provide steam to the steam turbine at the same time. The Bartow Plant can operate on all possible configurations of 4x1, i.e., 1x1, 2x1, 3x1, or 4x1. It also has the ability to augment heat through the use of duct burners. The combustion turbines can operate in "simple cycle" mode to generate electricity when the steam turbine is off-line.

9. The steam turbine is made up of a high pressure ("HP")/intermediate pressure ("IP") section and a low-pressure ("LP") section. Each of these turbine sections has a series of blades. As the steam passes through the blades, the steam exerts its force to turn the blades which, in their turn, cause a rotor to spin. The rotor is connected to a generator, and the generator produces electricity.

10. Steam leaving the HRSGs is introduced to the steam turbine at a high-pressure inlet into the HP turbine. The steam is returned to the HRSG for reheating, then enters the IP turbine. Finally, steam exiting the IP turbine is directed into the LP turbine.

11. The LP section of the steam turbine is dual-flow. The steam is admitted in the middle and flows axially in opposite directions through two opposing mirror-image turbine sections, each of which contains four sets of blades. After passing through the LP section, the steam exhausts into a condenser.

12. The sets of blades increase in size from the front to the back of the LP section. The blades get longer as the steam flows through the turbine. The steam loses energy as it passes through the machine and thus more surface area of blade is needed for the weaker steam to produce the force needed to spin the rotor. The final stage of blades in the LP section consists of 40" L-0 blades, the longest blades in the steam turbine.

13. Each L-0 blade is twisted, with a "root end" that connects it to the rotor hub, a snubber at the mid-point, and a shroud with air-foil tips (also called "Z-locks") at the top. As the steam turbine spins up to its operating speed of 3600 rpm, each blade elongates and starts to untwist slightly. The snubbers and Z-locks are designed to contact each other and create a stabilizing central and outer ring. If a snubber or airfoil tip fails, the blades can vibrate excessively and cause sudden and possibly catastrophic failure.

14. The Mitsubishi steam turbine was originally designed for Tenaska Power Equipment, LLC ("Tenaska"), to be used in a 3x1 combined cycle configuration with three M501 Type F combustion turbines connected to the steam turbine with a gross output of 420 MW of electricity. For reasons unexplored at the hearing, Tenaska never took delivery of the turbine. It was stored in a Mitsubishi warehouse under controlled conditions that kept it in like-new condition.

15. During the design and planning process for the Bartow Plant, DEF's employees responsible for obtaining company approval to build the plant, reported to senior executives that they had found this already-built steam turbine. The Business Analysis Package of DEF's project authorization documents stated that the Mitsubishi steam turbine "proved to be a very good fit for the 4 CT and 4 HRSG combinations."

16. Prior to purchasing the steam turbine, DEF contracted with Mitsubishi to evaluate the design conditions to ensure the steam turbine was compatible with the Bartow Plant's proposed 4x1 combined cycle configuration. Mitsubishi's evaluation included the review of over 300 heat

balances for the steam turbine that had been developed by Mitsubishi several years previous.

17. A "heat balance" is an engineering calculation that predicts the performance and output of power plant equipment based on different variables of ambient conditions and operating parameters. Any change in a variable causes a distinct "heat balance" and calculation of the expected plant output and performance.

18. One such variable was "power factor," a measure of the efficiency of how current is converted to useful power. A power factor of 1.0 indicates "unity," i.e., the most efficient possible conversion of load current. For each heat balance it calculated for the steam turbine, Mitsubishi used a power factor number that ranged from .9 to .949.

19. Jeffrey R. Swartz, DEF's Vice President of Generation, testified that DEF in fact operates the Bartow Plant at a power factor number that falls between .97 and .995.

20. Of the three hundred heat balances developed by Mitsubishi for the steam turbine, only two were included in the purchase agreement between Mitsubishi and DEF (the "Purchase Agreement"). These two heat balances formed the basis of the liquidated damages provision of the Purchase Agreement.

21. The first heat balance ("Heat Case 24") predicted that the steam turbine would produce approximately 389 MW of output with all four combustion turbines operating (4x1 configuration), no duct firing, and working at a power factor of .90. The second heat balance ("Heat Case 48") predicted that the steam turbine would produce approximately 420 MW of output with three combustion turbines operating (3x1 configuration), plus full duct firing, and working at a power factor of .949.

22. After Mitsubishi installed the steam turbine at the Bartow Plant, it tested Heat Case 24 and Heat Case 48 to verify that the Bartow Plant would generate the contractually-guaranteed output of 389 MW under the

configuration and parameters set for Heat Case 24 and 420 MW under the configuration and parameters set for Heat Case 48.

23. Mr. Swartz stated DEF's position that, by including Heat Case 24 and Heat Case 48 within the liquidated damages provision of the Purchase Agreement, Mitsubishi and DEF clearly intended to establish a contractually guaranteed *minimum* output the steam turbine would produce under the specific configurations and parameters set forth in each heat case. To buttress this position, Mr. Swartz pointed to section 3.2 of the Purchase Agreement, titled "Guaranteed Performance and other Guarantees for Acceptance Test."

24. Mr. Swartz further asserted that, prior to completion of the Purchase Agreement, Mitsubishi understood that DEF intended to operate the steam turbine in a 4x1 configuration with a power factor exceeding .949, which would result in the generation of more than 420 MW of electrical output.

25. Section 3.2 of the Purchase Agreement, titled "Guaranteed Performance and Other Guarantees for Acceptance Test," states, in relevant part:

> The guaranteed performances and other guarantees for Acceptance Testing of Steam Turbine, performed in accordance with Appendix C and other test procedures which may be mutually agreed in writing, are as follows:
>
> 3.2.1 Liquidated Damage Performance Guarantees
>
> 3.2.1.1 MPS][2] Net Steam Turbine Electrical Output 391.67 MW
>
> 3.2.1.2 MPS Net Steam Turbine Maximum Electrical Output 420.07 MW

26. The plain language of section 3.2.1 establishes an entitlement to liquidated damages if the steam turbine could not maintain an output of

[2] MPS stands for Mitsubishi Power Systems, Inc.

391.67 MW, with a maximum guaranteed output of 420.07 MW. It is unclear how Mr. Swartz translated this language into a guarantee that the steam turbine would produce a *minimum* of 420 MW.

27. In any event, the parties disagree as to the significance of the 420 MW maximum output designation. DEF and the Commission contend that the designated megawatt capacity of a steam turbine is not a control mechanism or a limit that the operator must stay below, but is the byproduct of operating the unit within the design parameters provided by the manufacturer at various combinations of such factors as steam flows, steam temperatures, steam pressures, exhaust pressures, ambient temperatures, and humidity.

28. DEF and the Commission contend that the numbers stated in the liquidated damages provision are calculated estimates of the conditions that will achieve either a 391.67 MW (the 4x1 configuration without duct firing in Heat Case 24) or 420.07 MW (the 3x1 configuration with duct firing in Heat Case 48) output. If DEF was able in practice to operate the steam turbine within the design parameters and achieve output in excess of 420 MW, then it was simply delivering maximum value to its ratepayers.

29. OPC asserts 420 MW is an operational limitation. The Mitsubishi steam turbine was designed to operate at a *maximum* output of 420 MW and any output over that amount threatened safe operation. OPC points out that Mitsubishi conducted extensive telemetry testing during Period 3 (from December 2014 until April 2016) that resulted in a document titled, "Duke Energy Bartow Report of Telemetry Test for 40" L-0," dated March 18, 2015 (the "Report"). The Report expressly stated that the "Bartow Steam turbine was designed to operate at 420 MW." The Report also stated that the "design point" of the steam turbine was 420 MW. These statements were supported by section 3.2.1.2 of the Purchase Agreement, which states that 420 MW is the "Maximum Electrical Output" of the steam turbine.

30. OPC points out that section 4.1 of the Purchase Agreement, titled "Performance Design Condition," expressly states: "The steam turbine and its

generator have been designed and manufactured under the conditions of these reference Heat Balance Diagrams [i.e., Heat Cases 24 and 48]. Any changes and/or modifications to this proposal must be carefully studied by both the Buyer and Seller. Seller has a right to reject the unacceptable changes and/or modifications against these Heat Balance Diagrams."

31. OPC notes that Heat Case 48 reached 420 MW of output using only three combustion turbines and HRSGs with duct firing. OPC further notes that the Bartow Plant had a fourth combustion turbine and HRSG, meaning that it had the ability to produce far more steam than needed to generate 420 MW of output when compared to the 3x1 application for which the steam turbine was originally designed.

32. The Mitsubishi steam turbine converts steam energy into rotational force (horsepower) that in turn drives an electric generator. The generator purchased by DEF for the Bartow Plant that was attached to the Mitsubishi steam turbine was manufactured by a different vendor and is rated at 468 MW. The generator thus was capable of reliably producing more electrical output than Mitsubishi stated its steam turbine was designed to supply.

33. The greater weight of the evidence establishes that the Mitsubishi steam turbine was designed to operate at 420 MW of output and that 420 MW was an operational limitation of the turbine.

OUTAGES AND BLADE FAILURES

34. DEF has classified the periods during which the Bartow Plant has been operational as: Period 1-- from June 2009 until March 2012; Period 2-- from April 2012 until August 2014; Period 3-- from December 2014 until April 2016; Period 4-- from May 2016 until October 2016; and Period 5-- from December 2016 until February 2017.

35. DEF placed the Bartow Plant into commercial service in June 2009. Later that year, DEF began operating the steam turbine above 420 MW

under varying system conditions. Mr. Swartz estimated that DEF operated the steam turbine above 420 MW about half the time between June 2009 and March 2012, the time span that has been designated as Period 1 of the five periods in question in this proceeding. The Bartow Plant operated for a total of 21,734 hours during Period 1.

36. In March 2012, while conducting a routine inspection of the steam turbine during a planned power outage, DEF found that five L-0 blades in the LP section had experienced moderate damage at the mid-span snubbers. All five blades were on the same row. DEF consulted with Mitsubishi regarding the damage. Mitsubishi inspected the blades and recommended replacing all of the L-0 blades on the affected end of the machine.

37. Mitsubishi concluded that the damage to the blades was caused by operation of the steam turbine over 420 MW, resulting in excessive steam flow to the LP section of the steam turbine, which created higher back-end loading on the L-0 blades. Up to this point, Mitsubishi had set no operating parameters or flow limits for the LP section. DEF and Mitsubishi had assumed that if DEF followed the operating pressure and temperature limits for the HP and IP sections of the steam turbine, then the inlet steam flow, pressure, and temperature for the LP section would be acceptable. After discovery of the blade failure in March 2012, Mitsubishi for the first time set an LP section inlet pressure limit of 118 psig (pounds per square inch in gauge), measured at the IP exhaust.[3]

38. Period 2 commenced in April 2012 and ended in August 2014, a period of 28 months. At the beginning of Period 2, DEF and Mitsubishi replaced all of the L-0 blades on the affected end of the LP turbine with re-engineered Type 1 L-0 blades.

39. During Period 2, DEF operated the steam turbine a total of 21,284 hours. For all but two hours of this period, DEF operated the steam turbine

[3] At this time, there was no pressure instrument at the LP inlet. Therefore, the IP exhaust was used as a proxy for estimating the pressure of the steam entering the LP inlet.

at less than 420 MW and complied with Mitsubishi's modified operating parameters. The reduction in power generation by the steam turbine due to the 118 psig pressure limit prompted DEF to ask Mitsubishi to determine what might be done to return generation to the levels attained in Period 1. In response, Mitsubishi performed a study and determined that it could redesign the L-0 blades to make them more robust and allow the Bartow Plant to generate 450 MW output.

40. During a planned outage beginning in August 2014, Mitsubishi replaced the re-engineered Type 1 blades used in Period 2 with newly-designed heavy duty blades ("Type 3 blades"), thus beginning Period 3. During this planned outage, DEF and Mitsubishi conducted an inspection of the Period 2 (re-engineered Type 1) blades. The inspection revealed a "moderate amount of surface fretting and galling" of the Z-locks consistent with ordinary usage over the course of Period 2. There was no damage noted to the snubbers. There was some blade wear and damage, described as "chipping at contact corners."

41. Between Period 2 and Period 3, Mitsubishi and DEF installed temporary blade vibration monitoring equipment in the steam turbine to allow for telemetry testing, which they expected would help them to understand why the L-0 blades were experiencing damage and to develop additional operating parameters to protect the equipment.

42. It was undisputed that DEF's operation of the steam turbine was prudent at all times during Period 2.

43. Period 3 commenced in December 2014 and ended in April 2016. During Period 3, DEF operated the steam turbine a total of 10,286 hours. DEF never exceeded 420 MW of output, except for a 240-hour period during which Mitsubishi and DEF intentionally operated above 420 MW to identify dynamic stresses within the steam turbine.

44. During Period 3, Mitsubishi performed extensive telemetry testing on the steam turbine. The testing was conducted in part because Mitsubishi

calculated that the Bartow steam turbine experienced approximately 15,000 foot pounds per hour per square foot ("lb./hr-ft^2") of steam flow and Mitsubishi's fleet experience had been limited to operation at approximately 12,000 lb./hr-ft^2 of calculated steam mass flow on last stage blades including the 40" L-0 blades. Mitsubishi was uncertain what impact the L-0 blades would experience at steam pressures exceeding 12,000 lb./hr-ft^2.

45. Mitsubishi concluded that high stresses on the L-0 blades were observed with blade loading above 16,200 lb./hr-ft^2 when combined with condenser pressure between 3 and 4.5 inches of mercury. Mitsubishi used this conclusion to establish a new operating parameter for the steam turbine that it called the "Avoidance Zone." The Avoidance Zone established steam loading limitations to avoid those combinations of LP turbine inlet pressure and condenser pressure that testing showed to be consistent with the appearance of "non-synchronous self-excited vibration," more commonly called "flutter," in the blades.

46. It was undisputed that DEF's operation of the steam turbine was prudent at all times during Period 3.

47. Despite DEF's having consistently abided by the operating parameters, including the Avoidance Zone, DEF and Mitsubishi's examination of the steam turbine at the end of Period 3 revealed that several of the Type 3 (v1) L-0 blades had experienced damage, particularly in the area of the Z-locks. DEF and Mitsubishi decided that all of the L-0 blades should be replaced once again. New Type 3 (v2) blades, with hard-facing on the mid-span snubber and the Z-lock contact surfaces, were installed.

48. Period 4 commenced in June 2016 and ended five months later in October 2016. During Period 4, DEF operated the steam turbine a total of 2,942 hours. DEF did not exceed 420 MW of output during this period and operated the steam turbine within the operating parameters established by Mitsubishi at all times save for 1.15 hours in the Avoidance Zone.

49. Just five months after the commencement of Period 4, DEF detected vibration changes in the LP turbine and stopped operation of the steam turbine to inspect the L-0 blades. During this inspection, DEF and Mitsubishi once again found several damaged L-0 blades. At the time of this blade damage, DEF was operating the steam turbine below 420 MW and observing the operating parameters established by Mitsubishi for this period.

50. It was undisputed that DEF's operation of the steam turbine was prudent at all times during Period 4.

51. Period 5 began in December 2016 and ended two months later in February 2017.

52. At the beginning of Period 5, DEF and Mitsubishi reinstalled Type 1 L-0 blades in the steam turbine, reasoning that those blades had experienced the longest period of uninterrupted operation since the Bartow Plant opened. The Type 1 blades installed during Period 5 were essentially the same design as the Type 1 blades used during Period 1. Mitsubishi softened the blade edges on the Type 1 blades after concluding that this minor modification would help prevent additional blade failures. The softening of the blade edges was the only intentional difference between the Period 1 Type 1 blades and the Period 5 Type 1 blades. The snubbers and Z-locks and the materials used to manufacture the blades were purported to be identical.

53. During Period 5, DEF operated the steam turbine a total of 1,561 hours. DEF never exceeded 420 MW of output during this period and operated the steam turbine within the operating parameters established by Mitsubishi for this period.

54. On February 9, 2017, the steam turbine was removed from service when DEF detected the presence of sodium in the steam water cycle. The cooling water used for the condenser is salt water from Tampa Bay. Mr. Swartz testified that any indication of sodium inside the condenser above minute amounts is alarming. During this shutdown, DEF performed an inspection of the steam turbine and discovered that a pressure relief safety

device known as a rupture disk had failed in the LP turbine and that the L-0 blades were damaged. DEF concluded that part of an L-0 blade snubber or Z-lock tip broke off and ruptured the rupture disk. This forced outage lasted until April 8, 2017.

55. Based on the sequence of events, DEF was able to determine with certainty that the blade damage during Period 5 occurred on February 9, 2017. At that time, DEF was operating the steam turbine below 420 MW and within the operating parameters established by Mitsubishi for this period.

56. It was undisputed that DEF's operation of the steam turbine was prudent at all times during Period 5.

57. During the February 2017 forced outage of the steam turbine, DEF continued to operate the Bartow Plant with the gas turbines running in simple cycle mode.

58. DEF took three primary actions in the wake of the Period 5 outage: a root cause analysis ("RCA") team, established after the first blade failure in Period 1, continued its mission to investigate and prepare an RCA; a restoration team was formed to bring the steam turbine back online; and a team was formed to evaluate a long-term solution for the steam turbine.

59. Because each previous version of L-0 blades had suffered damage, DEF did not believe re-installing any of the available types of blades would allow for continuous operation while a long-term solution could be devised.

60. Instead, DEF and Mitsubishi installed pressure plates in place of the L-0 blades as an interim solution that would bring the steam turbine back into operation quickly and give Mitsubishi and DEF time to develop a permanent solution. A pressure plate is a non-rotating plate that has holes drilled into it. The pressure plate reduces the pressure of the steam passing through a steam turbine, keeping the steam from damaging the unit's condenser. A pressure plate does not use the steam passing through it to produce electricity and therefore decreases the efficiency of a steam turbine.

The pressure plate applied by DEF limited the output of the steam turbine to 380 MW.

61. The parties have agreed and the undersigned accepts that the period of the steam turbine's "de-rating" from 420 MW to 380 MW should be calculated as running from April 2017 through the end of September 2019.

THE MITSUBISHI AND DEF ROOT CAUSE ANALYSES

62. Mitsubishi's telemetry testing during Period 3 led to institution of the Avoidance Zone. After finishing the testing, Mitsubishi produced the Report, which reiterated Mitsubishi's conclusion that the operation of the steam turbine in excess of 420 MW for much of Period 1 resulted in excessive steam flow to the LP section of the steam turbine, which created high back-end loading on the L-0 blades calculated as pounds per hour per surface area on the blades. The Report stated that the L-0 blades could be modified and output from the plant could be safely increased from 420 MW to 450 MW provided the LP exhaust pressure was limited to 126 psig.

63. In September 2017, Mitsubishi published the findings of its RCA in a 35-page "Bartow RCA Summary" ("Mitsubishi RCA"). The Mitsubishi RCA documented the company's attempt to discover why the Bartow Plant experienced L-0 blade failures that had not occurred anywhere else in the Mitsubishi fleet. The areas of investigation included the design, materials, manufacture, and assembly of the blades, and the operation of the Bartow Plant. Mitsubishi concluded that all blade damage from Periods 1 through 5 was caused by flutter. The Mitsubishi RCA provided different rationales for the damage to the L-0 blades from Periods 3 through 5: operation in the Avoidance Zone; low mechanical damping due to the application of hardening materials on the contact surfaces of the L-0 blades; and blending steam from the fourth gas turbine at high load.

64. The Mitsubishi RCA also stated that an upgraded blade design would be available in October 2018 and proposed the installation of a blade vibration monitoring system to achieve a 450 MW output.

65. After the discovery of the blade damage in March 2012, DEF formed an RCA team and began a years-long RCA process that ended with its own February 6, 2018, RCA report ("DEF RCA").

66. DEF's RCA agreed with Mitsubishi's that excessive vibration was the proximate cause of the L-0 blade failures. Noting that L-0 failures continued to occur even after steam inlet pressure and condenser back pressure limitations were imposed, DEF concluded that Mitsubishi's blade design failed to provide adequate design margin at the dynamic stress level within the steam turbine, even when operated according to the parameters set by Mitsubishi.

67. The term "design margin" refers to a tolerance level built into a piece of equipment that allows the equipment to be operated at some level above a prescribed operating limit without causing damage to the equipment.

68. At the hearing, OPC produced several documents that DEF's RCA team produced between 2012 and the final DEF RCA in February 2018. Mr. Swartz declined to call these documents "drafts" of the RCA, preferring to say they were "working papers" that provided snapshots of the RCA team's investigation at a given time. Mr. Swartz emphasized that only the February 2018 RCA report stated DEF's official position as to the cause of the blade failures.

69. The working papers indicate that as late as October 15, 2016, DEF agreed that the heat balances and other documentation that Mitsubishi provided with the steam turbine before 2008 contained limitations on turbine output. Those limitations provided an operational limit of 420 MW based on the Mitsubishi design point and the expected maximum electrical output.

70. The working papers show that as late as June 26, 2017, DEF maintained that one of "the most significant contributing factors toward root

cause of the history of Bartow Unit 4 L-0 events" was "Low Pressure (LP) Turbine Back-End Loading (>15,000 lb/hr/ft²)."

71. OPC accurately states that the DEF working documents demonstrate that during the RCA process, before and after the Period 5 event, DEF consistently identified excessive steam flow in the LP turbine as one of the "most significant contributing factors" toward blade failure over the history of the steam turbine, the same conclusion reached in the Mitsubishi RCA.

72. Mr. Swartz attempted to minimize the significance of the working papers by stating that DEF was obliged to investigate the issue of excessive steam flow because it had been identified by Mitsubishi as the root cause of the blade failures.

73. DEF's final RCA did not include a statement that excessive steam flow was a significant contributing factor in the blade failures. The final DEF RCA instead noted that "excessive steam flow" had been a "potential" operational factor that DEF examined during the RCA process. The RCA states that DEF had been unable to find a correlation between steam flow and the five failure periods. In particular, the RCA pointed out that Periods 2, 4, and 5 showed very few hours of operation in the Avoidance Zone but showed some damage to the L-0 blades nonetheless.

74. OPC concludes that the final DEF RCA was DEF's self-serving attempt to exonerate its own overloading of the steam turbine and to shift responsibility onto Mitsubishi for the design margins of the L-0 blades. DEF contends that it simply followed the data throughout the RCA process and arrived at the only conclusion consistent with the findings of its engineers.

POST-RCA ACTIONS

75. As noted above, pressure plates were installed in place of the L-0 blades at the conclusion of Period 5. The pressure plates allowed DEF to keep the steam turbine running at a lower level of output while it sought a permanent solution to the blade damage problem.

76. In 2018, DEF solicited proposals to implement a long-term solution that would allow it to reliably operate the steam turbine to support 450 MW of electrical output from the generator. Three vendors responded. Mitsubishi proposed a redesigned blade replacement. General Electric and Siemens each proposed retrofits of the steam path in the LP turbine. DEF selected the Mitsubishi proposal.

77. In December 2019, Mitsubishi installed redesigned 40" L-0 blades (Type 5), tested by Mitsubishi in the presence of DEF experts, in the Bartow Plant. Mitsubishi and DEF have also installed a permanently-mounted blade vibration monitoring device in the steam turbine to monitor operating conditions of the L-0 blades, allowing the modification of operating parameters before blade damage occurs. As of the hearing date, DEF had operated the Bartow Plant with the redesigned L-0 blades without incident on a 1x1, 2x1, and 3x1 configuration, but had yet to operate with all four combustion turbines.

78. OPC points out that in proposing its redesigned blades, Mitsubishi did not waver from the conclusion of its RCA. Mitsubishi stated the following as the first three bullet points in the introduction to its paper describing the testing of the upgraded blades:

> The Steam Turbine applied at Duke Bartow was originally designed for 420 MW as tandem compound unit with a double flow LP section, while the 4 on 1 fired configuration produces steam for 450 MW.
>
> The original blade loading limit of the 40" L-0 blades did not allow the unit to produce 450 MW, resulting in blade modification and testing.
>
> In the following 3 years, multiple forced outages were experienced due to last stage blade damage caused by high load stimulus and high energy blending in the 4 on 1 configuration which was not fully understood until conducting an elaborate collaborative RCA.

REPLACEMENT POWER AND DE-RATING COSTS

79. The record evidence established that the replacement power costs stemming from the February 2017 outage are $11.1 million.

80. Further, the record evidence established that DEF incurred replacement power costs from May 2017 through September 2019, the period of the "de-rating" of the steam turbine, i.e., the reduction in output from 420 MW to 380 MW while it operated with the pressure plate. Those costs, calculated by year, are $1,675,561 (2017), $2,215,648 (2018), and $1,125,573 (2019), for a total of $5,016,782.

81. Therefore, the total replacement power costs incurred as a result of DEF's operation of the steam turbine are $16,116,781, without considering interest.

DISCUSSION

82. As noted above, the parties have a fundamental disagreement as to the significance of the 420 MW maximum output designation that Mitsubishi placed on the steam turbine. The Energy Information Administration of the U.S. Department of Energy defines "generator nameplate capacity" as the "maximum rated output of a generator, prime mover, or other electric power production equipment under specific conditions designated by the manufacturer." There was no dispute that 420 MW was the "nameplate capacity" of the Mitsubishi steam turbine. OPC argues that the nameplate capacity of 420 MW is by definition an operational limitation and that operation of the steam turbine beyond the maximum rated output of 420 MW threatened safe operation.

83. OPC points to the fact that there are 32 steam turbines in Mitsubishi's worldwide fleet with a combined 57 rows of 40" L-0 blades. Only the Bartow Plant has experienced 40" L-0 blade failures caused by excessive blade vibration. The Bartow steam turbine had the highest L-0 blade loading in the entire fleet, in excess of 15,000 lb./hr-ft^2. The fleet average for back-end

loading was approximately 12,000 lb./hr-ft^2. OPC notes that the DEF RCA report does not explain why a lack of blade design margin can be the root cause of all the Bartow L-0 blade failures if no similar Mitsubishi steam turbine blade has experienced similar problems.

84. As to DEF's argument that excess loading cannot explain the L-0 blade failure in Period 5, when the steam turbine was operated within the parameters of Mitsubishi's Avoidance Zone, OPC replies that had DEF operated the turbine within its original operating limitations during Period 1, there is every reason to believe that the original L-0 blades would still be functioning, consistent with Mitsubishi's fleet experience. In other words, there would have been no Periods 2, 3, 4, or 5 but for DEF's actions during Period 1.

85. OPC points out that neither DEF nor any other subsidiary of Duke Energy had experience running a 4x1 combined cycle plant prior to purchasing the Mitsubishi steam turbine and commencing operation of the Bartow Plant. Further, neither DEF nor Mitsubishi had any experience operating a steam turbine at the loading levels required to produce 450 MW.

86. Given the lack of experience on either side, OPC contends that DEF should have consulted Mitsubishi before purchasing the steam turbine to ask whether Mitsubishi believed it was capable of an output in excess of its nameplate capacity of 420 MW. OPC accurately states that the record contains no evidence that DEF asked Mitsubishi to increase the design limit or design point of the steam turbine above 420 MW at any time prior to the March 2012 outage, that in retrospect marked the end of Period 1. DEF likewise never asked Mitsubishi, prior to March 2012, to reassess the conditions that would have been required to safely operate the steam turbine above 420 MW, or to increase the expected maximum electrical output of the steam turbine to a level above the 420 MW design point to accommodate the additional steam made available by a fourth combustion turbine and HRSG.

87. OPC's expert witness, Richard Polich, pointed out that Mitsubishi's consultant ran over 300 different heat balances to predict how the steam turbine would operate and not one of them showed it producing more than 420 MW. Mr. Polich believed that if the turbine had that capability, the manufacturer would have produced a thermal analysis to that effect. If Mitsubishi thought the turbine could be pushed to produce more, it would have instructed its consultant to design the unit with higher output.

88. Mr. Polich testified that the Mitsubishi steam turbine was an aftermarket unit designed for a much smaller steam flow and that Mitsubishi and its consultants factored that limitation into the design. To support his opinion, Mr. Polich pointed out that when DEF finally did ask whether the turbine could run past 420 MW, Mitsubishi replied that it would have to perform a study, indicating it believed there was a design limit on this unit.

89. DEF ran the unit beyond 420 MW without consulting Mitsubishi. Mr. Polich found it a tribute to the design of the original 40" L-0 blades that they did not suffer damage sooner than they did. The steam turbine operated from June 2009 until March 2012 before the blade damage was noted. It was impossible to state exactly when the blade damage occurred in Period 1, but Mr. Polich opined that the damage was most likely cumulative.[4]

90. Mr. Polich noted that the blade failure in Period 5 was the fastest of any period, though the Period 5 L-0 blades were supposedly identical to those used in Period 1, save for a minor softening of the blade edges. Mr. Polich further noted that the DEF RCA did not address why the blades lasted longer in Periods 1 and 2 than in the other three periods. Mr. Polich reasonably concluded that there had to be something about the blades' design in Period 1

[4] DEF made much of the fact that it could not be said precisely when during Period 1 the damage to the blades occurred, pointing out that there was a 50-50 chance that the blades were damaged when the turbine was operating below 420 MW. This argument fails to consider the cumulative wear caused by running the unit in excess of its capacity half of the time. The exact moment the damage occurred is beside the point.

that allowed them to last longer, and something in the design of the Period 5 blades that caused them to fail quickly.

91. Mr. Polich believed that the blades in Periods 2 through 5 were not similar enough to those in Period 1 to allow for a direct comparison. He noted that there were 28 months of operation below 420 MW during Period 2 and that there was basically no damage to the blades beyond the usual surface fretting and galling.

92. Mr. Polich thought that some of the things Mitsubishi did to improve the Z-locks and snubbers after Period 2 added to the problems instead of resolving them. Mr. Polich did not believe the five periods could be correlated, especially Period 5 where the blades were supposedly identical to those used in Period 1 yet failed with only 4% of the operating hours that the Period 1 blades sustained.

93. Mr. Polich testified that DEF would have acted prudently from both a warranty and a regulatory perspective by requesting written verification from Mitsubishi that the steam turbine could be safely operated above 420 MW of output.

94. Mr. Swartz countered that it would not be a "typical conversation" in the industry to ask Mitsubishi whether and how long the unit could be operated above 420 MW. He pointed out that pounds per hour per square foot of steam flow is not a parameter that can be measured during operation. It is a calculated number that DEF could not possibly have used to govern operation of the turbine.

95. Mr. Swartz testified that "420 MW" is the electrical output of the generator, which is coupled to the steam turbine. The steam turbine's operation is governed by parameters such as pressures, steam flows, and temperatures. Mr. Swartz stated that it is common in the industry to speak in terms of megawatts to get a feel for the size of the unit, but that generator output is dependent on many factors.

96. Mr. Swartz stated that when Mitsubishi criticized DEF for operations above 420 MW, it was using that term as a proxy for 15,000 lb/hr/ft² of steam flow. Mitsubishi's concern was always with the steam flow. It was his opinion that 420 MW was not an operational limit on the steam turbine.

97. Mr. Swartz testified that the Avoidance Zone established in Period 3 was related to steam flow. He stated that operation of the steam turbine above 420 MW could be correlated with steam flow, but many other factors are involved in determining what a generator can produce.

98. Mr. Swartz stated that the power factor was the key to DEF's ability to operate the steam turbine above 420 MW. Mitsubishi used Heat Case 48, with a power factor of .949, to predict an output of 420 MW. Using the same operating factors, DEF was able to run the steam turbine at a power rating between .97 and .995. Mr. Swartz testified that this increased efficiency enabled the Bartow generator to operate above 420 MW.

99. Mr. Swartz conceded that the Purchase Agreement contained an expected output of 420 MW, but asserted that this expectation was based on an assumed set of conditions that included a power factor of .949. Mr. Swartz emphasized that 420 MW was a *minimum* guaranteed output, at least from DEF's perspective. If DEF was able to obtain more, such was to the ultimate benefit of its ratepayers and was consistent with the operating limitations set forth in the Purchasing Agreement.

100. OPC responds that the record of this proceeding contains no indication that at any time during the five-year long, continuous, iterative RCA process did DEF's engineers suggest that the power factor of .949 in Heat Case 48 was an indication that the steam turbine output of 420 MW could be safely exceeded.

101. OPC points to several statements recorded during the RCA process indicating that DEF's engineers and Mitsubishi alike acknowledged that 420 MW was the design limit of the steam turbine: (1) Mitsubishi's characterization of 15,000 lb./hr.-ft.² as a loading limit; (2) an October 15,

2016, draft document with comments by DEF RCA team member Paul Crimi that characterized the heat balances as limiting the output of the turbine; and (3) DEF's documented efforts to have Mitsubishi increase the steam turbine output to 450 MW through blade design modifications.

102. OPC's essential criticism was that DEF pushed the Mitsubishi steam turbine beyond its operational limits, whether the issue is framed in terms of megawatts of electrical output beyond the design point or in terms of steam flow well in excess of Mitsubishi's fleet experience. The evidence was clear that Mitsubishi did not contemplate DEF's operation of the steam turbine beyond the heat balance scenarios set forth in the Purchase Agreement. The evidence was also clear that DEF made no effort before the fact to notify Mitsubishi of its intended intensity of operation or to ask Mitsubishi whether it could safely exceed the numbers stated in the Purchase Agreement. Mr. Swartz was unable to explain away this criticism and thus DEF failed to meet its burden of demonstrating that it prudently operated the Bartow Plant during the times relevant to this proceeding.

CONCLUSIONS OF LAW

103. DOAH has jurisdiction of the subject matter of and the parties to this proceeding. §§ 120.569 and 120.57(1), Fla. Stat.

104. The Commission has the authority to regulate electric utilities in the State of Florida pursuant to the provisions of chapter 366, including sections 366.04, 366.05, and 366.06.

105. An "electric utility" is defined as "any municipal electric utility, investor-owned electric utility, or rural electric cooperative which owns, maintains, or operates an electric generation, transmission, or distribution system within the state." § 366.02(2), Fla. Stat.

106. DEF is an investor-owned electric utility operating within the State of Florida subject to the jurisdiction of the Commission pursuant to chapter 366.

107. OPC, FIPUG, and White Springs are parties to the Fuel Clause docket, which included the issues to be resolved here, and as such are entitled to participate as parties in this proceeding.

108. This is a de novo proceeding. § 120.57(1)(k), Fla. Stat. Petitioner, DEF, has the burden of proving, by a preponderance of the evidence, that it acted prudently in its actions and decisions leading up to and in restoring the unit to service after the February 2017 forced outage at the Bartow Plant. Additionally, DEF must prove by a preponderance of the evidence that no adjustment to replacement power costs should be made to account for the fact that after the installation of a pressure plate in March 2017, the Bartow Plant could no longer produce its rated nameplate capacity of 420 MW. *Dep't of Transp. v. J.W.C. Co.*, 396 So. 2d 778, 788 (Fla. 1st DCA 1981); § 120.57(1)(j), Fla. Stat.

109. The legal standard for determining whether replacement power costs are prudent is "what a reasonable utility manager would have done, in light of the conditions and circumstances that were known, or should [have] been known, at the time the decision was made." *S. Alliance for Clean Energy v. Graham*, 113 So. 3d 742, 750 (Fla. 2013).

110. DEF failed to demonstrate by a preponderance of the evidence that its actions during Period 1 were prudent. DEF purchased an aftermarket steam turbine from Mitsubishi with the knowledge that it had been manufactured to the specifications of Tenaska with a design point of 420 MW of output. Mr. Swartz's testimony regarding the irrelevance of the 420 MW limitation was unpersuasive in light of the documentation that after the initial blade failure, DEF itself accepted the limitation and worked with Mitsubishi to find a way to increase the output of the turbine to 450 MW.

111. DEF's RCA concluded that the blade failures were caused by the failure of Mitsubishi to design the 40" L-0 blades with adequate design margins. This conclusion is belied by the fact that the L-0 blades have failed at no other facility in the Mitsubishi fleet. Mitsubishi cannot be faulted for

failing to design its blades in a way that would allow an operator to run the turbine consistently beyond its capacity.

112. Mitsubishi's more plausible conclusion attributed the blade failure in Period 1 to DEF's operation of the steam turbine in excess of 420 MW, resulting in excessive steam flow to the LP section of the steam turbine, which in turn caused high back-end loading on the L-0 blades.

113. Mr. Polich persuasively argued that it would have been simple prudence for DEF to ask Mitsubishi about the ability of the turbine to operate continuously in excess of 420 MW output before actually operating it at those levels. DEF understood that the blades had been designed for the Tenaska 3x1 configuration and should have at least explored with Mitsubishi the wisdom of operating the steam turbine with steam flows in excess of those anticipated in the original design.

114. The record evidence demonstrated an engineering consensus that vibrations associated with high energy loadings were the primary cause of the L-0 blade failures. DEF failed to satisfy its burden of showing its actions in operating the steam turbine in Period 1 did not cause or contribute significantly to the vibrations that repeatedly damaged the L-0 blades. To the contrary, the preponderance of the evidence pointed to DEF's operation of the steam turbine in Period 1 as the most plausible culprit.

115. DEF demonstrated by a preponderance of the evidence that its actions during Periods 2 through 5 were prudent.

116. DEF argues that even if it failed to exercise prudence during Period 1, those actions were so attenuated by DEF's subsequent actions during Periods 2 through 5 that the outage and de-rating that began in 2017 cannot be fairly attributed to DEF's failures from 2009 through March 2012. If the imprudent operation in Period 1 did not cause the Period 5 outage, then the imprudent operation cannot be a basis for disallowance of the replacement power costs at issue.

117. OPC argues that Periods 2 through 5 would not have been necessary had DEF operated the turbine within its original operating limitations during Period 1. OPC contends that, based on the experience of the L-0 blades in all other Mitsubishi plants, there is every reason to believe that the original L-0 blades would still be functioning but for DEF's overstressing them in Period 1.

118. OPC states that the applicable standard for prudence review is how a prudent and reasonable utility manager would have operated a new steam turbine under the conditions and circumstances which were known, or reasonably should have been known, when decisions were made in 2008 through 2012. OPC argues that it was imprudent and unreasonable for DEF to regularly supply steam to the steam turbine at levels causing the steam turbine to operate above the design point of 420 MW, especially given the fact that the steam turbine was not designed for the Bartow Plant and was sold to DEF with an unequivocally stated design point.

119. It is speculative to state that the original Period 1 L-0 blades would still be operating today had DEF observed the design limit of 420 MW. It is not speculative to state that the events of Periods 2 through 5 were precipitated by DEF's actions during Period 1. It is not possible to state what would have happened from 2012 to 2017 if the excessive loading had not occurred, but it is possible to state that events would not have been the same.

120. In his closing argument, counsel for White Springs summarized the equities of the situation very well:

> You can drive a four-cylinder Ford Fiesta like a V8 Ferrari, but it's not quite the same thing. At 4,000 RPMs, in second gear, the Ferrari is already doing 60 and it's just warming up. The Ford Fiesta, however, will be moaning and begging you to slow down and shift gears. And that's kind of what we're talking about here.
>
> It's conceded as fact that the root cause of the Bartow low pressure turbine problems is excessive

> vibrations caused repeatedly over time. The answer to the question is was this due to the way [DEF] ran the plant or is it due to a design flaw? Well, the answer is both.
>
> The fact is that [DEF] bought a steam turbine that was already built for a different configuration that was in storage, and then hooked it up to a configuration ... that it knew could produce much more steam than it needed. It had a generator that could produce more megawatts, so the limiting factor was the steam turbine.
>
> On its own initiative, it decided to push more steam through the steam turbine to get more megawatts until it broke.
>
> * * *
>
> So from our perspective, [DEF] clearly was at fault for pushing excessive steam flow into the turbine in the first place. The repair which has been established ... may or may not work, but the early operation clearly impeded [DEF's] ability to simply claim that Mitsubishi was entirely at fault. And under those circumstances, it's not appropriate to assign the cost to the consumers.

121. The greater weight of the evidence supports the conclusion that DEF did not exercise reasonable care in operating the steam turbine in a configuration for which it was not designed and under circumstances which DEF knew, or should have known, that it should have proceeded with caution, seeking the cooperation of Mitsubishi to devise a means to operate the steam turbine above 420 MW.

122. Given DEF's failure to meet its burden, a refund of replacement power costs is warranted. At least $11.1 million in replacement power was required during the Period 5 outage. This amount should be refunded to DEF's customers.

123. DEF failed to carry its burden to show that the Period 5 blade damage and the required replacement power costs were not consequences of DEF's imprudent operation of the steam turbine in Period 1.

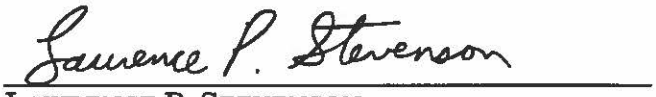
124. The de-rating of the steam turbine that required the purchase of replacement power for the 40 MW loss caused by installation of the pressure plate was a consequence of DEF's failure to prudently operate the steam turbine during Period 1. Because it was ultimately responsible for the de-rating, DEF should refund replacement costs incurred from the point the steam turbine came back online in May 2017 until the start of the planned fall 2019 outage that allowed the replacement of the pressure plate with the redesigned Type 5 40" L-0 blades in December 2019. Based on the record evidence, the amount to be refunded due to the de-rating is $5,016,782.

125. The total amount to be refunded to customers as a result of the imprudence of DEF's operation of the steam turbine in Period 1 is $16,116,782, without interest.

RECOMMENDATION

Based upon the foregoing Findings of Fact and Conclusions of Law, it is RECOMMENDED that the Public Service Commission enter a final order finding that Duke Energy Florida, LLC, failed to demonstrate that it acted prudently in operating its Bartow Unit 4 plant and in restoring the unit to service after the February 2017 forced outage, and that Duke Energy Florida, LLC, therefore may not recover, and thus should refund, the $16,116,782 for replacement power costs resulting from the steam turbine outages from April 2017 through September 2019.

DONE AND ENTERED this 27th day of April,2020, in Tallahassee, Leon County, Florida.



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NOTICE OF RIGHT TO SUBMIT EXCEPTIONS

All parties have the right to submit written exceptions within 15 days from the date of this Recommended Order. Any exceptions to this Recommended Order should be filed with the agency that will issue the Final Order in this case.